Demonstrating creation of habitat for beneficial insects – Year 1

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Abstract:

Many people are interested in protecting pollinators by creating good habitat for them. The same habitat (flowers and grasses of varied shapes and sizes that provide blooms throughout the growing season) is also good for other beneficial insects (and similar creatures like spiders) that are natural enemies of pests. There are a lot of different ways to establish these plants and manage weeds during the establishment process. We wanted to demonstrate some of these options, while also collecting data on how effective and costly each method was. In this first year of the project we used six different methods to establish habitat plants for beneficial insects, collected data on the time and costs required and weed control achieved using each method, and visually documented the growth of the habitat plants during the first growing season. Not surprisingly, using transplants resulted in much larger habitat plants by the end of the season compared to direct seeding, but was also much more expensive. Successfully establishing habitat for beneficial insects is a multi-year process. In subsequent years, we will continue to collect similar data. We will also document and quantify the beneficial insects (pollinators and natural enemies) and pests that can be found in the habitat we have created, and the adjacent Christmas tree planting.

Background and justification:

From farmers to backyard gardeners to 4-H clubs to golf course managers, there continues to be strong interest in protecting pollinators. Providing perennial plants that produce pollen and nectar or offer places for pollinators to live and are protected from pesticides is one popular way to protect pollinators. In and around agricultural fields, this same habitat can also shelter and feed other beneficial arthropods like natural enemies of pests (e.g., Grab et al. 2018, McCabe et al. 2017). It could also harbor pest arthropods. In backyard gardens, attracting natural enemies to a small vegetable plot is likely to be much more cost effective than releasing natural enemies.

There are many ways to establish perennial habitat for beneficial insects, and these methods typically involve some combination of the following three choices:

- Transplant small seedlings or direct seed
- Plant in the spring or in the fall
- Type of weed management

All three choices involve very different labor and supply costs, and are also expected to contribute to the speed and success of establishment. People who want to protect pollinators or attract natural enemies want to know which method is best, and facing a broad array of choices without advice or guidance can be daunting. Choosing an inexpensive but slow establishment method could also lead to frustration and abandonment of a pollinator habitat project when planting seeds in the spring does not produce a beautiful weed-free meadow of flowers by August.

This project will provide data to help stakeholders select a beneficial insect habitat establishment method that fits their budget, timeline, and goals. It will also create a demonstration field site where stakeholders and educators can view and learn about habitat establishment. Finally, it will enable us to collect additional data on the benefits of this habitat (which beneficial arthropod species are attracted, impacts on pests in an adjacent Christmas tree planting) and potential drawbacks (whether pest species are also attracted, and how many).

Objectives:

1. Establish habitat (perennial wildflowers and grasses) using different methods and timing for planting and weed control in a research field at Cornell AgriTech in Geneva, NY.
2. Record the costs of materials and the amount of time required for establishment using each method.
3. Document the success and speed of establishment with each method during the first several years after establishment.
4. Quantify the arthropods present (pollinators, natural enemies, and pests) in the habitat plots established by different methods and compare them to arthropods present in nearby mowed grass.
5. Quantify the impact of these habitat plots on pest populations in the adjacent Christmas tree planting.

Procedures:

We used six different methods to establish habitat for beneficial insects during Spring, Summer, and Fall of 2018 (Table 1). The field in we used had been fallow for a number of years (mowed occasionally), and the entire field was treated with herbicide in Fall 2017 before treatments were applied. Treatment E was our control, where we did nothing but mow (after some initial herbicide applications). Tillage was done either with large equipment pulled by a tractor (e.g., disk) in Spring 2018, or with a walk-behind rototiller in Summer and Fall 2018. Mowing in Summer and Fall 2018 was done with a walk-behind mower. Weeding was done by hand. Mulch applied to treatment B was chipped shrub willow. Plastic laid in treatment F was 6 mil clear plastic left over from a high tunnel and was laid over plots to solarize soil (i.e., kill weed seeds with heat). A full description of the procedures used for each treatment in Year 1 of this project can be found online.

Table 1. Summary of the six methods (plus a control) used to establish habitat for beneficial insects at a research farm in 2018.

Treatment	**Fall 2017**	**Spring 2018**	**Summer 2018**	**Fall 2018**
A	Herbicide	Herbicide, transplant	Weed 2x	Replace dead plants
B	Herbicide	Till, transplant, mulch	Weed 2x	Replace dead plants
C	Herbicide	Till, direct seed	Mow 3x	Mow 1x
D	Herbicide	Till, plant buckwheat	Mow 1x, till, plant buckwheat	Mow 1x, transplant
E - control	Herbicide	Herbicide	Mow 3x	Mow 1x
F	Herbicide	Till, lay plastic	Continue solarization	Remove plastic, direct seed
G	Herbicide	Herbicide/till	Herbicide 2x, till 1x	Till 1x, direct seed

The wildflower and grass species we used in the habitat plots were selected from lists of native perennials recommended as resources for pollinators in the Northeastern United States (e.g., by the Xerces Society). Plots that were direct-seeded were planted with the Showy

Northeast Native Wildflower & Grass Mix from Ernst Seeds. When we purchased seeds in Spring 2018, the mix contained 25 species (Table 2), but the exact mixture varies from year to year. We planted 16 different species in plots that were transplanted (Table 3).

Table 2. Species (and the proportion of the mix represented by each species) included in the Showy Northeast Native Wildflower and Grass Mix from Ernst Seeds used when direct seeding habitat for beneficial insects.

Common name	Ecotype (if specified)	Scientific name	Proportion
Little bluestem	Albany Pine Bush - NY Ecotype	*Schizachyrium scoparium*	32.58%
Sideoats grama, 'Butte'		*Bouteloua curtipendula*	23.02%
Virginia wildrye	PA Ecotype	*Elymus virginicus*	16.61%
Purple coneflower		*Echinacea purpurea*	4.15%
Partridge pea	PA Ecotype	*Chamaecrista fasciculata*	3.61%
Black eyed susan		*Rudbeckia hirta*	3.61%
Lanceleaf coreopsis		*Coreopsis lanceolata*	3.58%
Butterfly milkweed		*Asclepias tuberosa*	2.36%
Tall white beardtongue	PA Ecotype	*Penstemon digitalis*	2.32%
Marsh (dense) blazing star (spiked gayfeather)		*Liatris spicata*	1.78%
Smooth blue aster	NYEcotype	*Aster laevis*	1.19%
Golden alexanders	PA Ecotype	*Zizia aurea*	0.60%
Orange coneflower	Northern VA Ecotype	*Rudbeckia fulgida var. fulgida*	0.59%
Ohio spiderwort	PA Ecotype	*Tradescantia ohiensis*	0.59%
Aromatic aster	PA Ecotype	*Aster oblongifolius*	0.48%
Wild bergamont	Fort Indiantown Gap-PA Ecotype	*Monarda fistulosa*	0.48%
Wild senna	VA & WV Ecotype	*Senna hebecarpa*	0.48%
New England aster	PA Ecotype	*Aster novae-angliae*	0.42%
Narrowleaf mountainmint		*Pycnanthemum tenuifolium*	0.36%
Gray Goldenrod	PA Ecotype	*Solidago nemoralis*	0.35%
Zigzag aster	PA Ecotype	*Aster prenanthoides*	0.24%
Early goldenrod	PA Ecotype	*Solidago juncea*	0.24%
Yellow false indigo (Horeseflyweed)	PA Ecotype	*Baptisiatinctoria*	0.12%
Hairy beardtongue		*Penstemon hirsutus*	0.12%
Maryland senna		*Senna marilandica*	0.12%

Table 3. Species transplanted into plots to establish habitat for beneficial insects. Each plot was 5 ft wide by 23 ft long.

Common name	Scientific name	Number of plants per plot
Anise hyssop	*Agastache foeniculum*	2
Common milkweed	*Asclepias syriaca*	3
Blue false indigo	*Baptisia australis*	2
Lanced-leaved coreopsis	*Coreopsis lanceolata*	3
Purple coneflower	*Echinacea purpurea*	2
Boneset	*Eupatorium perfoliatum*	3
Wild bergamot	*Monarda fistulosa*	2
Catmint	*Nepeta faassinii*	2
Tall white beard tongue	*Penstemon digitalis*	3
Black-eyed susan	*Rudbeckia fulgida va. Fulgida*	1
Little bluestem (grass)	*Schizachyrium scoparium*	11
Showy goldenrod	*Solidago speciosa*	1
New England aster	*Symphyotrichum novae-angliae*	3
Ohio spiderwort	*Tradescantia ohiensis*	2
NY ironweed	*Vernonia noveboracensis*	2
Golden alexanders	*Zizia aurea*	3

Results and Discussion:

Economics. Not surprisingly, there were big differences in how much time and money we spent on different treatments this first year (Table 4). The costs and hours below are for a total area of 460 ft^2 (0.01 A) per treatment (4 plots). Most of the cost differences were due to the huge difference in seed versus transplant expenses. We paid about $2 per plant and needed 180 plants for each treatment. In contrast, we spent about $12.50 on seed for each treatment. An itemized list of the costs and time invested in each method is available online.

Table 4. Summary of total costs for the different methods used to establish habitat for beneficial insects.

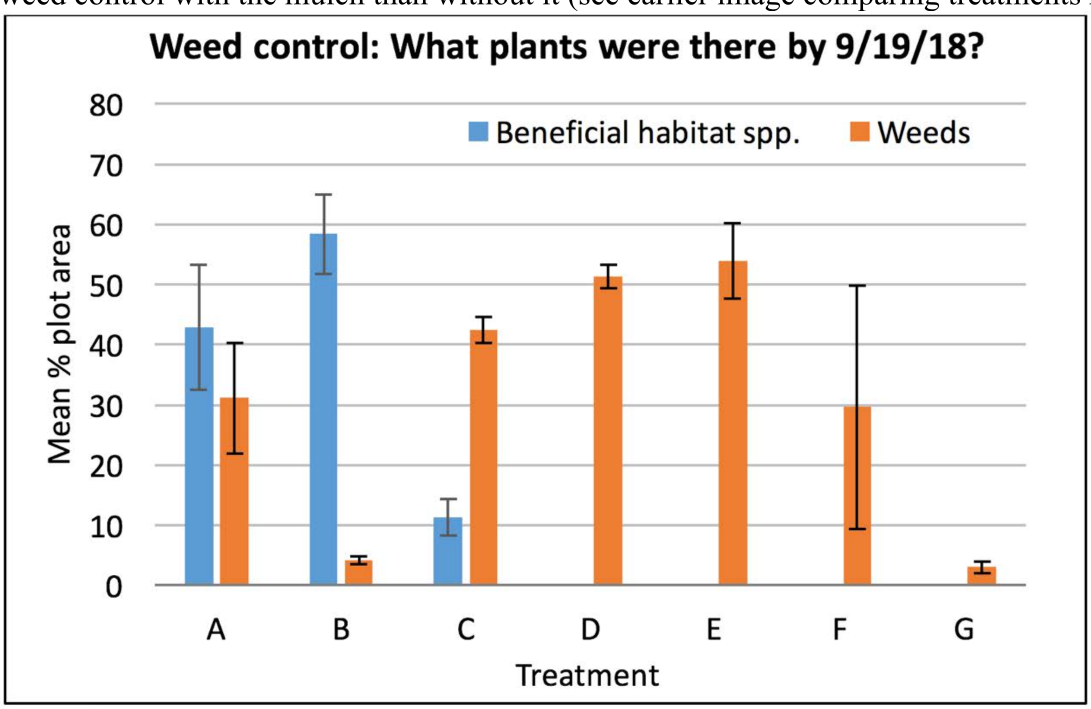
Treatment	Supply costs	Time (person hrs)
A – spring transplant	$417.12	13.2
B – spring transplant & mulch	$539.29	20.4
C – spring seed	$17.75	4.4
D – buckwheat & fall seed	$390.55	10.3
E – control	$2.32	2.6
F – solarize & fall seed	$148.02	10.2
G – herbicide/tillage & fall seed	$22.04	6.3

Establishment. There were big differences in how quickly the plants established. By September, both treatments (A and B) that had been transplanted in the spring looked like well-established gardens, with large, blooming wildflowers. But in spite of similar amounts of time spent hand weeding both treatments, weed control was much better with the mulch (B) Most of the spring transplants survived well until the fall. Although all the transplants came in 50-cell flats, some were larger than others. We noticed that the larger transplants survived better. We were fortunate to be able to plant into nice moist ground, so except for a little water on the day of transplanting, we didn't irrigate. Survival might not have been as good with different planting conditions.

In contrast, the much less expensive treatment C was not looking too impressive even by October. A few partridge peas and black eyed Susans bloomed this year (below right), but otherwise treatment C did not look much different from the control plots. In mid-summer, it looked like we were growing more ragweed than wildflowers (below left).

Two of the treatments (F and G) were planted with seeds in Fall 2018, and one treatment (D) was transplanted this fall. So it is really too early to tell how successful those treatments were. The pictures below were taken in October. We will continue to document growth of beneficial insect habitat plants in these treatments during 2019.

Weed control. The graph below shows the average percent of the surface area of each plot that was covered with weeds versus planted beneficial habitat species on September 19, 2018. Averages are means of four plots per treatment, and error bars show standard errors. While we spent about the same amount of time weeding treatments A and B, we achieved much better weed control with the mulch than without it (see earlier image comparing treatments A and B).



In treatment B, we spread mulch about 3 inches deep around the transplants. If we were to do this again, a thicker mulch layer might be better. The number of weeds that had grown through the mulch just a month after transplanting was disappointing. Below on the left is part of the plot that had not been weeded yet. On the right is the part that had been weeded on July 6. You can also see from this picture that there was a lot of lambsquarters in this field.

We will have to wait until next year to really understand how weed control is working in treatment C. Remember, the strategy was to slowly deplete the annual weed seedbank by allowing weeds to germinate, but preventing them from producing more seed. This is not supposed to be a quick establishment method, and it wasn't.

Ideally, we would have transplanted into Treatment D shortly after mowing. But the second crop of buckwheat was starting to set seed by the end of August, and our transplants weren't scheduled to arrive until the end of September. So we mowed the buckwheat early to prevent it from contributing its own seed to the weed seedbank. But this meant that a lot of weeds had time to germinate before we transplanted the habitat plants. The buckwheat certainly suppressed a lot of weeds during the growing season, and hopefully this will help reduce weeds next year. But this does not show up in the weed assessment graph above since the weed assessment was conducted three weeks after mowing. Before it was mowed, the buckwheat also attracted a lot of pollinators and some other beneficial arthropods. Pictures of the buckwheat plots at several timepoints during the season are below.

Overall, we were pleased with how the solarization worked. Treatment F required little maintenance except for a little weed control around the edges of the plastic just once during the summer to prevent more weed seed production and shading of the plots. We did learn that solarization will not control purslane. Actually, the purslane thrived *only* under the clear plastic, and nowhere else in the field.

Especially the plot that had the most purslane also had some other grass weeds growing under the plastic by the time we removed the plastic in October. We think the purslane pushed the plastic away from the soil so that the soil did not heat up as much, allowing other weeds to germinate and grow. Some other plots were virtually weed-free when we pulled the plastic up in October. Our soil temperature probe happened to be in the plot with the most purslane, and we still achieved maximum soil temperatures of 120 °F (at a depth of about 3 inches), compared to 90 °F in a nearby control (treatment E) plot. We cut all the weedy vegetation off at the ground before direct seeding the beneficial habitat plants. We wanted a bare seed bed for planting beneficial habitat seeds without disrupting the soil and encouraging more weed seeds to germinate.

Treatment G (the plots that had been alternately treated with herbicide and tilled) looked best in terms of weed control in our September assessment. Like treatment C and all the treatments planted (by seed or by transplant) in the fall, we will get a better idea next year of how effective this method was at suppressing weeds. When habitat plants were direct-seeded in October, this treatment still looked quite good (see right).

Choosing a fall seeding date. One thing we struggled with this fall was deciding when to plant the wildflower and grass seed mixture. One source recommended the seeds be planted sometime between October and December. We were cautioned that if we planted the seeds too early, some species (especially black eyed Susan) might germinate this fall, and the young seedlings would be killed by an early frost before they established. But we were also afraid of waiting too long and not being able to till the soil (treatment G, only) if it got too wet. And we wanted a nice smooth seedbed. In treatment F, we suspected that leaving the clear plastic on into November would protect the weeds from the cooler weather. But we worried that taking it off too early would only allow more weed seeds to blow onto the bare ground.

Finally, we compromised and planted the seeds on October 18 and 19, after our first hard frost, and once it looked like the nighttime temperatures would be in the 40's (or below) for the next 10 days. It was only a week after the last tillage in treatment G, and the soil was still relatively dry. This worked out well because late October and November got very wet very quickly in the Finger Lakes, and it would have been difficult to till and rake in the seed.

Next steps. In 2019 we will start quantifying the beneficial arthropods in these plots, but already in 2018 we began seeing both natural enemies and pollinators, including lady beetles, lacewings, predatory stink bugs (even if they were eating butterfly larvae), spiders, hoverflies, predatory beetles, butterflies, and several types of bees. Some pictures are below.






Impacts. We have just begun sharing results from the first year of this project (three blog posts, two presentations). As the project continues, we will collect additional data on long-term success of the different establishment methods, the types of arthropods attracted, and impacts on pest pressure in nearby Christmas trees. These data will enable us to make better recommendations about choosing to plant habitat for beneficial insects, and choosing a method. The location of these plots (in Geneva, NY on a Cornell AgriTech research farm) will make it easier for us to hold field meetings where both growers and extension agents can visit the habitat plots and learn how to create similar beneficial insect habitat.

Project location:
The demonstration plots are located in Ontario County, however, the results could be applicable throughout New York State.

Resources developed in 2018:

Dunn, Amara. "Creating habitat for beneficial insects – early summer 2018 project update." *Biocontrol Bytes*. New York State Integrated Pest Management Program, Cornell University, 18 June 2018. Accessed 25 June 2018. https://blogs.cornell.edu/biocontrolbytes/2018/06/18/creating-habitat-for-beneficial-insects-early-summer-2018-project-update/

Dunn, A.R. "Pollinator Habitat." *ThinkIPM*. New York State Integrated Pest Management Program, Cornell University, 9 October 2018. Web, accessed 13 October 2018. https://blogs.cornell.edu/nysipm/2018/10/09/pollinator-habitat/

Dunn, A.R., Eshenaur, B., Lamb, E. "Creating habitat for beneficial insects: Project update at the end of the first year" *Biocontrol Bytes*. New York State Integrated Pest Management Program, Cornell University, 30 November 2018. Web, accessed 30 November 2018.

Fact sheet about Year 1 results from the project: https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/e/7831/files/2018/11/establishment-handouts-all-treatments-1l0t0kp.pdf

Short video explaining what a "beneficial insect" is: https://www.youtube.com/watch?v=Xqk0JSCBId4&feature=youtu.be

In addition to the photos included in this report, numerous photos are available showing the process of establishing these plots during 2018, habitat plants in bloom, what the plots looked like at various times during the 2018 growing season, and what arthropods were seen in the plots. Some are available in NYS IPM Flickr albums, or contact Amara Dunn (arc55@cornell.edu) if you are looking for a specific image.

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Literature cited:

Grab, H., Danforth, B., Poveda, K., and Loeb, G. 2018. Landscape simplification reduces classical biological control and crop yield. Ecol Appl. 0(0):1-8.

McCabe, E., Loeb, G., and Grab, H. 2017. Responses of crop pests and natural enemies to wildflower borders depends on functional group. Insects. 8:73.